A Grading System for Intracranial Arteriovenous Malformations Applicable to Endovascular Procedures

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Summary

A grading system was designed by the first author (B.S.) specifically to predict the difficulty of endovascular obliteration of an intracranial arteriovenous malformation based on the feeding arterial characteristics, and the venous drainage system.

We have retrospectively reviewed our cases of intracranial arteriovenous malformation, with special interest in those underwent endovascular embolization. The grading of the AVM was by either our new proposed system or by a surgically oriented grading system. Both systems were compared from the endovascular point of view. Using the present proposed grading system intracranial arteriovenous malformation may range from grade I to grade V. The difficulty of the endovascular embolization correlated well with the new grading system, while in most cases it did not reflect the degree of difficulty of the procedure when a pure surgical grading system was used. This newly designed grading system has a better prediction value to the difficulty of performing endovascular embolization than does other grading systems.

Introduction

In order to provide the best therapeutic option for each specific patient with intracranial AVM an accurate estimation of the morbidity and mortality of the proposed procedure should be compared with that of natural history of the disease and with other therapeutic options.

Several authors have addressed purely surgically oriented classification of IC-AVM. To our knowledge, no previous classification system has graded IC-AVM in relation to a proposed endovascular embolization of a specific lesion. The present proposed grading system evaluate the IC-AVM from the endovascular point of view.

Methods

Parameters of importance in treating IC-AVM are numerous. We limited our grading system to factors that we observed to be most important variables in IC-AVM embolization. These are: 1) Arterial feeders, and 2) Draining veins

Feeding arteries

a) *Number of feeders*: The more the feeding arteries or the involvement of more than one arterial territory or perforating arteries increases the procedure duration, difficulty, and probability of complication. A nidus fed by four arteries or less is allotted one point, when more than four arteries exist or if perforators or choroidal arteries are involved then two points are given.

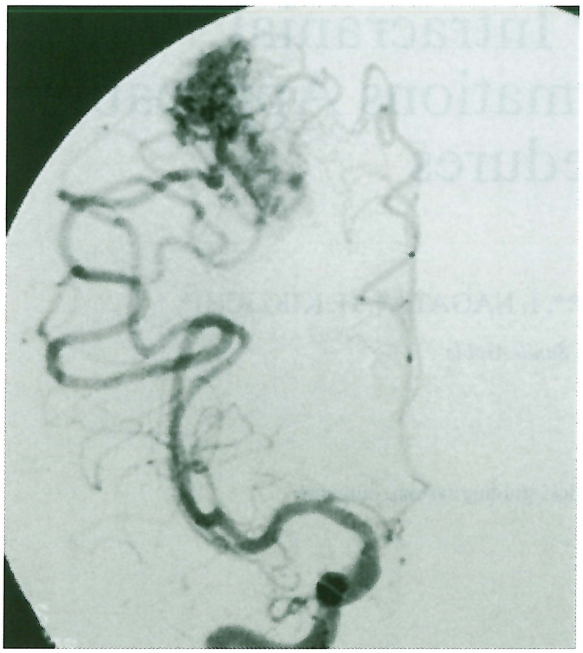

Figure 1 Right internal carotid angiography, lateral (A) and AP (B) view, showing a low grade surgically accessible IC-AVM. Small size, non-eloquent location, and superficial draining vein; grade I. By applying the proposed endovascular grading system this is a grade III.

b) *Feeder origin*: The length and tortuousity plays an important rule. For supratentorial IC-AVM a proximal feeder comes off from the first or second divisions of the main arteries from the circle of Willis. Beyond that the feeder is considered as distal. Feeders of infratentorial IC-AVM are considered as distal. A proximal nidus is given zero point, and distally located lesion is given one point.

c) *Feeder type*: One of the most important variables that determine the difficulty and safety of the endovascular procedure is the type of the feeding artery. When an end-on artery supplies the IC-AVM it will be relatively easy and safe to occlude it. While embolizing IC-AVM that is supplied by transit type of artery will carry certain risk depending on the region of the brain supplied by the same artery. We give one point for the transit feeder and zero point for the end-on feeder.

Venous drainage system

Draining vein stenosis: Premature closure of draining vein will lead to increased intranidal pressure with risk of bleeding. This risk of premature closure is highest when the draining vein is stenotic. A stenotic draining vein is given one point and those without stenosis is given zero point.

Results

To grade an IC-AVM using the proposed system the angiography is carefully inspected and the variables are obtained. The numerical values from each variable are summated to give the AVM grade. The grading system ranges between the lowest grade I and highest grade V. Grade I IC-AVM would be fed by four or less, 1, end-on, 0, artery(s) from same origin, that are proximal to the circle of Willis, 0, and no stenosis of the draining veins, 0. The highest grade V IC-AVM would have more than four feeders, of different origin, or perforators or choroidal arteries are involved, 2, of which some are of transit type, 1, the feeders have distal origin, 1, and the draining vein is stenotic, 1.

Figure 1 shows IC-AVM located at the right posterior parietal region and drained by a single superficial draining vein. This is considered as a grade I by Spetzler and Martin grading system and is relatively easy and safe to resect surgically. On the other hand it is expected to be more difficult to occlude by endovascular embolization. By applying our grading system this nidus is fed by branches from the ACA and MCA, 2, end-on arteries, 0, of distal origin, 1, and has a non-stenotic draining vein, 0. This IC-AVM will be a grade III, reflecting the true expected difficulty to occlude it.

Figure 2 presents deep seated IC-AVM that is located in the posterior corpus callosum and drains into the deep venous system; grade III Spetzler and Martin. The same nidus is graded as I by our proposed system; single feeder, 1, a direct continuation of the pericallosal artery the second division of MCA, 0, end-on type, 0, and drained by non-stenotic vein, 0. The patient underwent endovascular embolization resulting in complete cure.

Discussion

The aim of treating intracranial arteriovenous malformation is to remove the cumulative risk of bleeding with its inherent mortality and morbidity [1-4]. Several papers have proposed a grading system for IC-AVM to predict the dif-

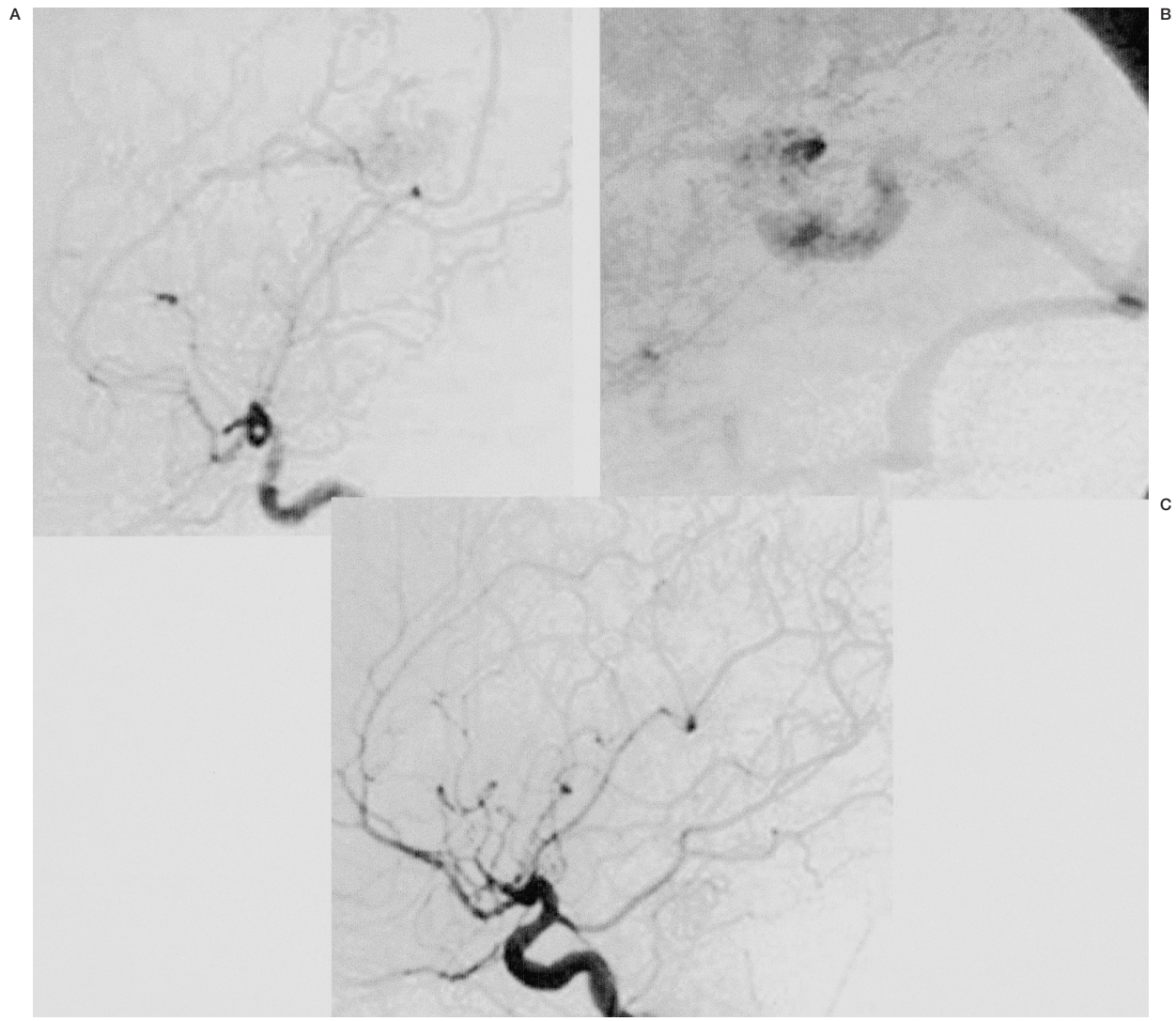

Figure 2 Internal carotid angiography, lateral view, pre-embolization (A and B) and post-embolization (C), showing a grade III Spetzler and Martin IC-AVM that was graded as I by our system and was completely obliterated by embolization.

ficulty of performing surgical resection [5-7]. Although these grading systems may be adequate enough to serve as a predictor, they all have a pure surgical view and have limited application when speaking about other therapeutic modalities such as endovascular embolization and stereotactic radiosurgery.

We are proposing a new grading system that applies specifically to endovascular procedures. This is based on the characters of the arterial feeding and venous draining systems. In the pure surgical grading systems the size of the IC-AVM and the eloquency of the region it occupies has a definite effect on the difficulty of the surgical excision [7]. On the other hand, they reflect no direct concern for the endovascular interventionists, as they will not directly face the IC-AVM nidus. The same applies to the deep venous drainage. The more the superficial is the lesion the easier it is to be exposed and resected surgically.

This superficial IC-AVM is far from the circle of Willis and is probably supplied by a long tortuous feeding artery.

In this situation it becomes difficult for the microcatheter to travel the long tortuous vascular channel till it enters superselectively into the nidus. Furthermore, with slow flow

across the malformation the difficulty to catheterise the nidus using the flow-guided microcatheter will be higher. Situations do exist where an IC-AVM may have the same grade on both grading systems which may reflect the same degree of difficulty & risk when using either technics.

Conclusions

The need for accurate IC-AVM grading system specifically applicable for endovascular procedure does exist.

We have developed this classification system to predict the difficulty and benefits of embolization. This system will make comparison between endovascular centers much more accurate. As the third option for treating IC-AVM is stereotactic radiosurgery, we urge the experts in this field to develop a peculiar grading system that fits more accurately to their procedure.

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